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ABSTRACT

One novice subject's learning about the tennis serve was measured (over a 4-day period) by recording the subject's gestures and verbal remarks. This case study compared gestures, verbal remarks, skills, and form data to see which types best discriminated between days 1 to 4, and it also attempted to determine if discriminant analyses were suitable for such comparisons. Verbal data selected included: subject's evaluation of a serve, part of the serve described, and number of items the subject referenced. Gesture data selected included: body part used in the gesture, size of gesture, type of gesture, and number of gestures per serve. Results showed that generally gesture and verbal data appeared to better discriminate among days of early skill learning than did skill and form rating data. It was also found that the use of both contingency table and discriminant analyses is valuable. (Author/JMK)

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COMPARISON OF VERBAL, GESTURE, AND SKILL DATA OBSERVED IN COMPLEX MOTOR SKILL ACQUISITION

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Abstract

COMPARISON OF VERBAL, GESTURE, AND SKILL DATA OBSERVED IN COMPLEX MOTOR SKILL ACQUISITION. E. L. Lindquist, San José State University.

Researchers studying the acquisition of complex motor skills (such as the tennis serve) are often perplexed with their results which they hoped would show progress but didn't. In most cases, skill test or form rating data were used as the dependent variables. Since skill performance is so inconsistent in the early stages of learning, particularily while the motor program is being developed, skill test and form data may not be the best data to determine if learning has occurred. In the early stages of learning (days one to four), it might be more advantageous to look at gesture or verbal data both of which may be more indicative of consolidation of information than skills tests. This exploratory case study was designed to (1) compare gesture, verbal, and skill test and form data to see which types best discriminated between days one to four and would, therefore, better serve the researcher trying to document the learning process and (2) to determine if discriminant analyses were suitable for such comparisons. Three types of verbal data were selected: subject's evaluation of serve, part of serve subject described, and number of items subject referenced. Four types of gesture data were selected: body part used in the gesture, size of gesture, type of gesture, and number of gestures per serve. Hewitt's serve accuracy and speed tests and a form rating were used. The data were collected on television tape by a professional crew and consisted of four one-half hour learning sessions involving 277 serves performed by a female college freshman who was a novice in tennis. The data were transcribed at different times and, since they were recorded on separate channels, did not contaminate each other. Both discriminant (direct and Rao's V) and contingency table analyses were used to analyse the data since it might be argued that the type of data

collected were not suitable for ratio level analyses. Direct discriminant analysis correctly classified 63% of the cases using all the variables. Rao's V discriminant analysis eliminated form and accuracy data and correctly classified 59% of the cases. Separate contingency table analyses found significant X^2s between day and all variables except accuracy. Therefore, the accuracy skill test was the poorest discriminator between days in both types of analyses. The order in which the variables were accepted according to their ability to discriminate between days were: all gesture data, speed, all verbal data. Except for form data, discriminant and contingency table analyses provided similar findings but discriminant analyses were much less tedius to evaluate. However, the contingency table analyses provided a clearer and more interesting picture of differences between the data by day. In conclusion, gesture and verbal data appeared to better discriminate between days of early skill learning than did skill and form rating data except for speed; however, since the speed score is dependent upon the accuracy score in the Hewitt test, it would be difficult to argue for its inclusion. Therefore, the time involved in collecting form and accuracy data might not be justified in the early stages of learning. The use of both contingency table and discriminant analyses is recommended since, although the findings complemented each other, more about the differences between variables between days is found by using both analyses. More studies should be done using the same and different skills to see if the findings hold.

Comparison of Verbal, Gesture, and Skill Data Observed in Complex Motor Skill Acquisition

Researchers studying the acquisition of complex motor skills (such as the tennis serve) are often perplexed with their results which they hoped would show progress but didn't. In most cases, skill test or form rating data were used as the dependent variables. A number of years ago, results from the first 15 trials of a discrimination reaction time task study (Fleishman and Hempel, 1956) indicated that approximately 35-40% of the early learning trials was devoted to spatial relations and verbal abilities which they called "nonmotor" abilities. Adams (1971) divided the stages of learning into two parts: verbal-motor and motor, indicating the emphasis placed on verbalization in the early stage of learning. Other researchers have also placed a large emphasis on the cognitive components during the early stages of acquiring a complex motor skill.

Although these nonmotor abilities decrease systematically with practice, they cannot be ignored in early skill learning and they might provide a better basis for understanding the learning process than motor abilities. Since skill performance is so inconsistent in the early stages of learning, gesture or verbal data may be more indicative of consolidation of information than motor data.

Review of Related Literature

Justifications, Assumptions, Limitations, and Delimitations

Data

Gesture data. According to Spiegel and Machotka (1974), only a small portion of literature is devoted to forming an assessment of others in respect to body expressions and, with a few exceptions, these assessments are limited to face even though Vernon (1972) said that the entire positioning of the body relative to others is communicative. The assumption made in using gesture data is that inner states can be deduced from outer manifestations; there is no independent criteria of the accuracy of these deductions (Spiegel and Machotka, 1974).

Verbal data. Gottschalk (1972) has recommended the content analysis of taperecorded and transcribed speech for objectively recording and measuring both emotional and cognitive changes. A difference of opinion exists as to whether having a person speak and perform is interfering.. Since most people speak and perform successively, not simultaneously, the verbalizations should help or reinforce rather than interfere. A large amount of literature, according to Conrad (1972), shows that when adults say verbal items aloud in a variety of short-term memory paradigms, recall is better than when items are not named. Shea (1977) showed labelling to have a positive effect on short-term motor memory.

Gesture vs. verbal data. Since visual, verbal, and kinesthetic inputs are channel-specific, it is believed they serve different purposes and convey different messages. Some researchers such as Archer and Akert (1977) believe gestures rather than words are more indicative of what a person

is thinking since gestures reflect one's feelings and emotions. Others such as Graham and Argyle (1975) find gesture and speech to be linked down to the level of the syllable and that when gestures are eliminated, people rely on verbal means of conveying spatial information which is conveyed better by gesture.

Four days as the grouping variable. An earlier study by Lindquist (1968) found that the mental plan for performing a tennis serve was established by the fourth day.

Three types of data. Few studies have attempted to analyze all three types of data on the same subject. Bradley (1969) found a high degree of correspondence between the oral, nonverbal, and posture data; facial and verbal data were the most similar.

Methodology

Videorecording. According to Birdwhistell (1970), in order to best understand the meaning of a movement, the total context of the movement must be examined and filming is necessary in order to accomplish this. Butterfield (1977) found filming important if vigilance is a problem and, also, observations can be rotated randomly allowing one observer to do the analysis rather than a team which would require training in observation techniques (Mehrabian, 1971). Subjects become accustomed to recording equipment in a short time.

Use of one female observer. In respect to judging others, Rosenthal et al. (1974) found women to be better judges than men of nonverbal data and task-oriented people better than people-oriented people.

Discriminant analysis. Lawlis and Sweney (1973) discussed an

application of discriminant function to correlated samples when researchers wished to show change over time with a combination of variables. They pointed out that discriminant analysis had not been used with longitudinal data. Overall (1974) designed a nonmetric discriminant analysis computer program but it only handled three variables. Comparing the SPSS discriminant analysis program by Nie, Hull, Jenkins, Steinbrenner, and Bent (1975), which can use 10 variables in the analysis, with separate chi square analyses may show the value of this function to this type of analysis.

Purposes

The three objectives of this exploratory case study were (a) to determine what types of gesture and verbal data could be collected, (b) to compare gesture, verbal, skill test, and form data to see which might best discriminate between days one to four of early skill learning, and (c) to compare discriminant analyses with contingency table analyes to determine appropriateness.

Method

Pilot study data collection

Data were collected on television tape by a professional crew and consisted of four one-half hour learning sessions involving 277 serves performed by a paid female college freshman who was a novice in tennis. The subject was given instructions on the purpose of the serve. Loopfilm and still pictures were provided on a table behind the subject. She was free to view the serve at any time and to ask questions. No information was offered unless requested. The subject was asked not to practice

between learning sessions. Detailed instructions and explanations of the experimental setup was presented in Lindquist (1968, 1971).

Data Analysis

Four types of gesture data were selected: body part used for gesture (PART), size of gesture (SIZE), type of gesture (TYPE), and number of different gestures per serve (DIFFS); three types of verbal data: part of serve referenced (VERBAL), evaluation of serve (VALUE), number of different parts of the serve referenced per serve (ITEMS); and three skill data: accuracy, speed, and form. Absolute and relative frequencies of these variables were obtained to determine more discrete categories for further analysis. Correlations (chi square, Spearman's, and Pearson's) were found to determine relationship between variables.

Following the coding and classification of data, direct and Rao's V discriminant analyses (Nie et al., 1975) were used to analyze the data. The former to see how using all the variables would discriminate between days and the latter to see which variables were best discriminators. Day was used as the grouping variable. Contingency table analyses using the SPSS Crosstabs computer program (Nie et al., 1975) cross-tabulated each variable by day and performed the respective chi square analysis to see if additional as well as comparable information coud be obtained.

Results

The codings and absolute frequencies and categorizing of the 10 variables selected for the verbal analyses can be seen in Table 1.

Insert Table 1 about here

The codings, absolute frequencies, and categories for the four gesture variables can be seen in Table 2 and the absolute frequencies of the accuracy and speed test scores can be seen in Table 3.

Insert Tables 2 and 3 about here

The form scores were placed in six discrete categories and the absolute frequencies of each category can also be seen in Table 3. A perfect form score was 60 so there was no ceiling effect.

The subject served 34 serves on day 1, 80 serves on day 2, 97 serves on day 3, and 66 serves on day 4. The only reasonably high correlation between variables was between VERBAL and ITEMS, $r_s = .79$, $p = .001$.

The summary of the direct analysis can be seen in Table 4. The standardized discrimination function coefficients appear in Table 5.

Insert Tables 4 and 5 about here

The centroids of groups in reduced space can be seen in Table 6.

Insert Table 6 about here

Using all the variables resulted in correctly classifying 63.33% of the cases.

Rao's V stepwise discriminant analysis summary can be seen in Table 8, the discriminant function summary in Table 9, the standardized discriminant function coefficients in Table 10, and the centroids of groups in reduced space in Table 11. The stepwise elimination included

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Insert Tables 8-11 about here

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four gesture variables (PART, TYPE, SIZE, AND DIFFS), one skill test (SPEED), and the three verbal variables (VALUE, VERBAL, ITEMS). Accuracy and form were eliminated from the analysis as not contributing further to the discrimination between days. The combination of the remaining variables correctly classified 53.40% of the grouped cases.

Significant chi squares were found between day and all variables except accuracy, X^2 (18) = 20.65, p = .30 (in agreement with discriminant analysis). However, FORM was significant, X^2 (15) = 48.68, p = .000 (not in agreement with discriminant analysis). Except for the difference in accepting the form variable, the discriminant and chi square analyses complemented each other. Some of the interesting findings from the crosstabulation analyses going from day 1 to day 4 were: decrease in reject statements, increase in number of items referenced, and part referenced went from small to large in respect to the verbal variables. In respect to the gesture variables, there was a decrease in negative gestures, an increase in uncertain and acceptable gestures, increase in number of different gestures, and a decrease in the size of gestures.

Discussion and Conclusion

The verbal, gesture, and skill variables selected for the analyses were unrelated to each other except for VERBAL and ITEMS. The unrelatedness of the gesture and verbal variables showing they serve different purposes and convey different messages was in keeping with Archer and Akert's (1977) findings. Verbal and gesture variables were more discriminating than motor skill data (except speed) in determining the learner's progress the first four days when the learner was forming her motor program. Except for FORM, discriminant and chi square analyses complemented each other and provided clear evidence of discrimination between days using verbal and gesture data. More case studies need to be done on the same skill and on other complex sports skills to determine if results will hold.

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Table 1

Verbal Data

Verbal Part	Absolute frequency
1. Goal data (accuracy, speed)	84
2, Ball toss	79
3. Position of racket face	40
4. Wrist, grip, spin	39
5. Contact problems	14
6. Rhythm, timing	11
7. Backswing, swing	7
8. Body position, court position	3
Value	
1. Accept	21
2. Uncertain	37
3. Questionable	5
4. Reject	214
Items	
# referenced per serve	
0	3
1	151
2	102
3	12
4	2
5	7

Table 2

Gesture Data

Code	Part Involved	Absolute frequency
1.	Hand	0
2.	Foot	0
3.	Face-head	170
4.	Arm	25
5.	Leg	4
6.	Shoulder	0
7.	Back	0
8	Abdominal-hip	1
9	Whole body	73
10.	Missing	1

Code	Size of Gesture	Absolute frequency
1	Small	213
2	Medium	37
3	Large	25
4	Missing	1

Code	Type of Gesture	Absolute frequency
1.	Accepting	22
2.	Uncertain	30
3.	Questionable	1
4.	Rejecting	224

# Different Gestures	Absolute frequency
0	1
1	194
2	63
3	15
4	3
6	1
Wild	1

Table 3

Skill Test and Form Scores

Accuracy		Speed	
Score	Absolute frequency	Score	Absolute frequency
0	215	0	217
1	11	1	6
2	40	2	32
3	5	3	22
4	1	4	0
5	2		
6	3		

Form

Category Code	Scores in Category	Absolute frequency
I	1-29	5
2	30-35	25
3	36-41	59
4	42-47	96
5	48-53	82
6	54-59	10

Table 4

Direct Discriminant Analysis

Summary

Discriminant Function	Eigenvalue	Relative Percentage	Canonical Correlation
1	1.76211	78.55	.799
2	0.34278	15.28	.505
3	0.13837	6.17	.349

Functions Derived	Wilks' Lambda	X^2	DF	Sig
0	.2368	74.897	30	0.000
1	.6542	22.060	18	0.339
2	.8784	6.739	8	0.565

Table 5

Standardized Discrimination Function Coefficients

Variable	Type	Func 1	Func 2	Func 3
Part	Gesture	256.40579	- 80.52208	-259.32564
Type	Gesture	0.65190	0.05632	2.09285
Size	Gesture	459.51493	929.17684	192.34295
Diffs	Gesture	-714.99142	-848,86228	66.97274
Acc	Skill	- 0.02678	0.27099	0.39213
Spd	Skill	- 0.17591	- 0.29111	- 0.43354
Form	Skill	- 0.51349	.46350	- 0.50384
Value	Verbal	- 0.12997	0.13582	- 2.57041
Items	Verbal	0.14651	- 0.33139	- 0.09034
Verbal	Verbal	0.05356	0.19522	- 0.02337

Table 6

Centroids of Groups in Reduced Space

Group	Func 1	Func 2	Func 3
1	1.83020	-0.36266	-0.27582
2	0.37571	0.64689	0.50207
3	-0.48178	-0.49561	0.13452
4	-0.47346	0.43958	-0.44042

Table 7

Prediction Results From

Direct Discriminant Analysis

Day	Predicted % Day 1	Predicted % Day 2	Predicted % Day 3	Predicted % Day 4
1	87.5	12.5	0.0	0.0
2	16.7	50.0	16.7	16.7
3	0.0	12.5	70.8	16.7
4	0.0	18.7	31.2	50.0

Percent of grouped cases correctly classified = 63.33

Table 8

Summary Table

Rao's V Stepwise Discriminant Analysis

Step #	Variable Entered	Rao's V F to remove	Wilks' Lambda	Sig.	Rao's V	Change in Rao's V	Sig. of Change
1	Part	15.97266	0.84878	0.000	47.925	47.93	0.00
2	Type	20.01562	0.69338	0.000	115.771	67.05	0.00
3	Verbal	18.01562	0.57664	0.000	182.631	66.86	0.00
4	Size	7.61719	0.53102	0.000	217.476	34.84	0.00
5	Diffs	7.41797	0.48988	0.000	250.682	33.21	0.00
6	Items	5.81250	0.45952	0.000	271.013	20.33	0.00
7	Value	1.44971	0.45204	0.000	276.490	5.48	0.14
8	Spd	1.41113	0.44486	0.000	282.816	6.33	0.097

Table 9

Rao's V Discriminant Function

Summary

Discriminant Function	Eigenvalue	Rel. %	Canonical Corr.	Functions Derived	Wilks' Lambda	X^2	DF	Sig.
				0	.44	215.46	24	.00
1	.83	79.07	.67	1	.81	54.52	14	.00
2	.19	16.94	.39	2	.96	10.91	6	.09
3	.04	3.98	.20					

Table 10

Standardized Discriminant Function Coefficients

Variable	Func 1	Func 2	Func 3
Part	-.49	-.52	-.48
Type	-.40	.31	-.25
Size	-.36	.11	-.41
Diffs	.28	.32	-.58
Spd	.10	-.04	-.41
Value	-.13	-.53	.56
Verbal	-.40	.40	.18
Items	.09	-.60	.06

Table 11

Centroids of Groups in Reduced Space

Group (Day)	Func 1	Func 2	Func 3
1	-1.23337	-.46446	-.299912
2	-0.53690	.19014	.25143
3	.66615	-.35886	.03882
4	.32407	.53635	-.20586

Table 12

Prediction Results from

Rao's V Discriminant Analysis

Day	N of Cases	Predicted % Day 1	Predicted % Day 2	Predicted % Day 3	Predicted % Day 4
1	34	73.5	20.6	5.9	0.0
2	79	27.8	39.2	8.9	24.1
3	95	2.1	4.2	64.2	29.5
4	65	10.8	21.5	23.1	44.6

Percent of grouped cases correctly classified = 53.48%